Edge fueling for low recycling and toward improved UEDGE/WBC coupling*

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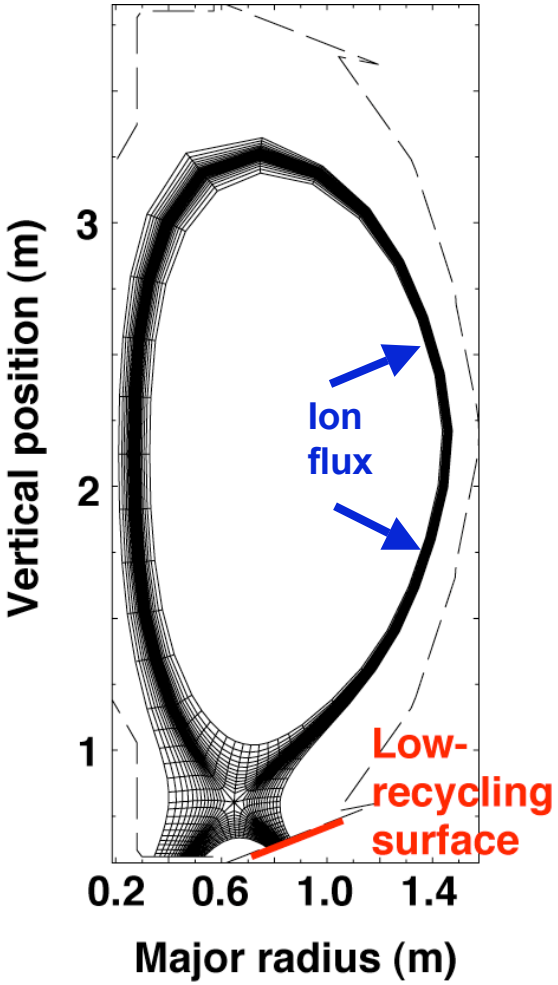
Particle fueling and lithium core-influx are key issues for low-recycling tokamaks utilizing lithium walls

1. **Hydrogen pumping by lithium creates the need to continuously fuel the tokamak at a high rate compared to the high-recycling regime**
   - Does the poloidal location matter?
   - Does the radial location matter?

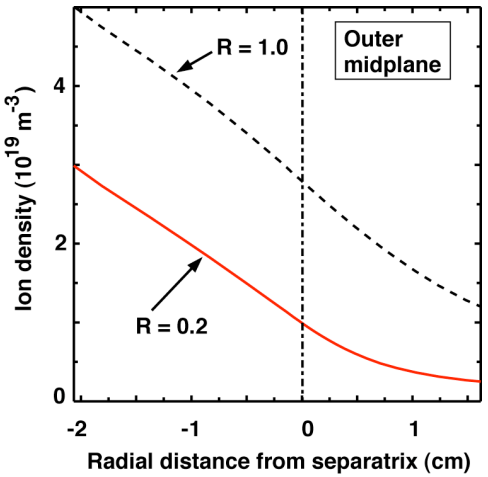
2. **Consistent near-sheath (WBC) and whole-edge (UEDGE) coupling requires improved techniques in the non-trace impurity limit**
   - Electron density from Li near the wall similar to that from hydrogen
   - UEDGE needs time-dependent Li density everywhere to proceed

UEDGE base-case for Lithium module has a large ion flux across the core boundary - how to supply it?

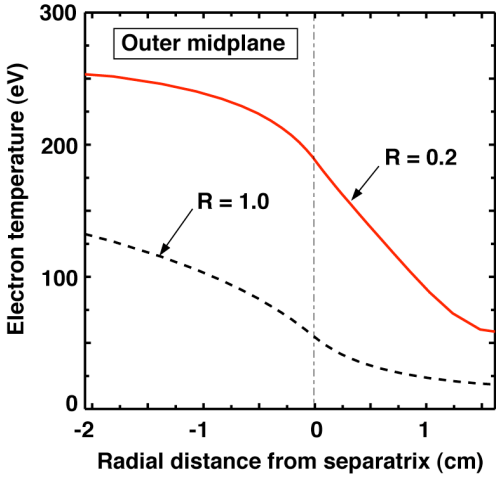
- **Use 2D UEDGE fluid transport with kinetic corrections**
- **Begin with a base-case with high recycling (shot 109034, Porter)**
  - P_{core} = 2 MW
  - D = 0.5 m^2/s, χ = 1.5 m^2/s
  - R = 1.0
  - Wall gas albedo = 0.95
  - Carbon impurity



Ion density



Electron temperature



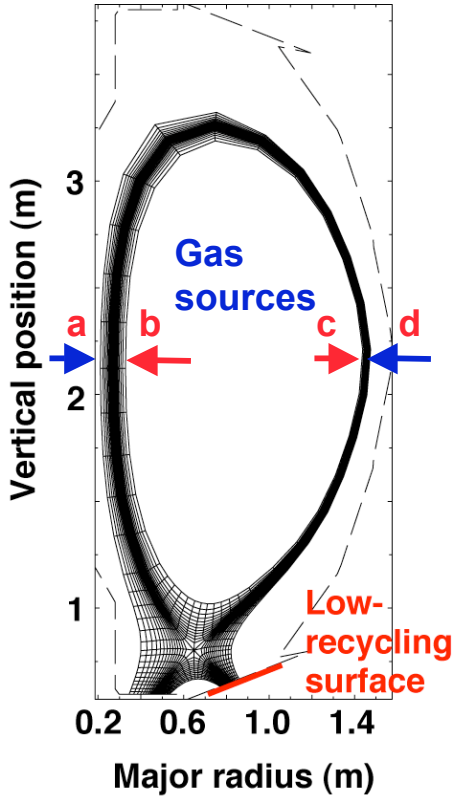
The magnitude of a gas source at 4 locations locations are compared for the level driving I_{core} -> 0

- **Four gas injection locations**
  - Two (a and d) are wall gas puffing from outer and inner midplane walls
  - Two others (b and c) are localized midplane sources inside separatrix for a very simple 2D model of deep fueling (pellet or high-speed nozzle)

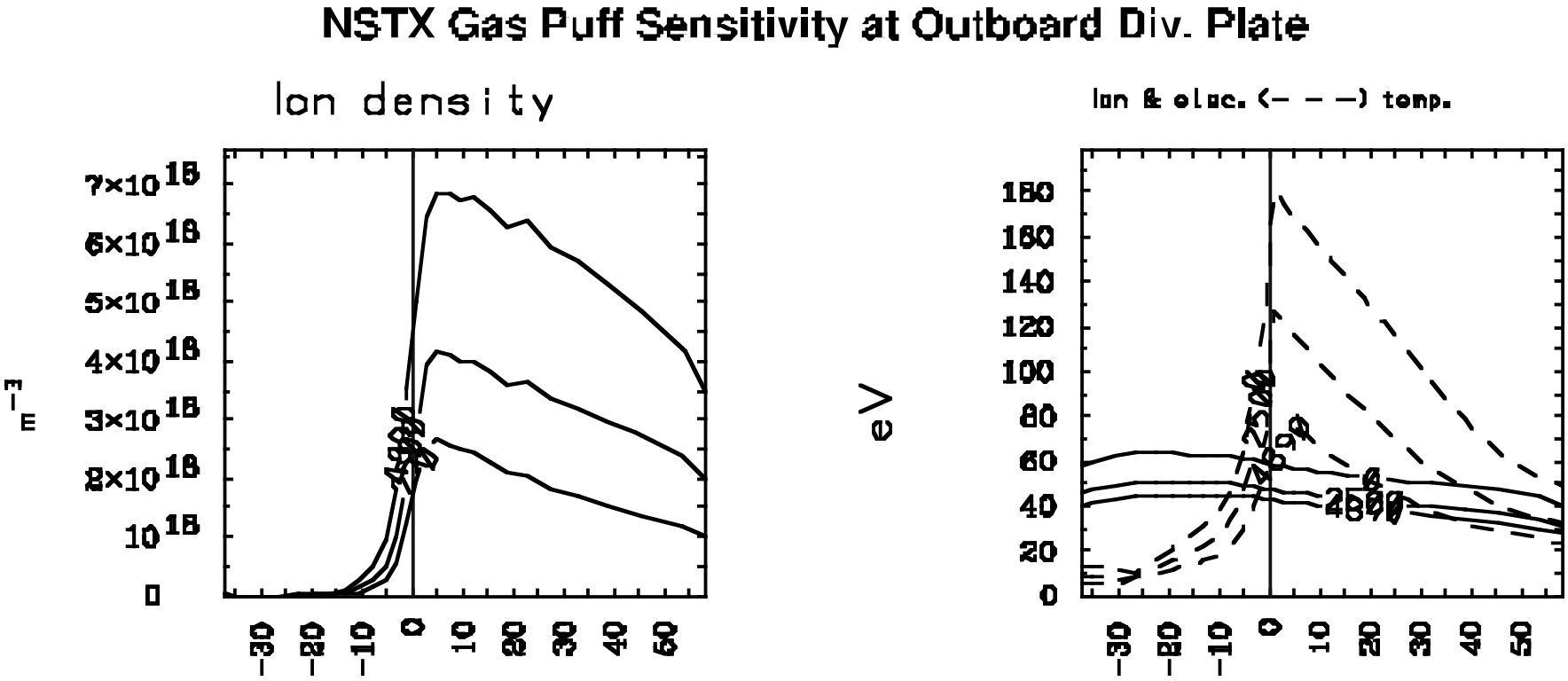
- **Resulting gas source for $I_{core} = 0$**
  - Wall gas puffs a and d differ by ~1.5, outer best

    I_a = 7.2 kA and I_c = 4.9 kA
  - "Pellet" injections (b,c) show large difference between inner and outer cases:

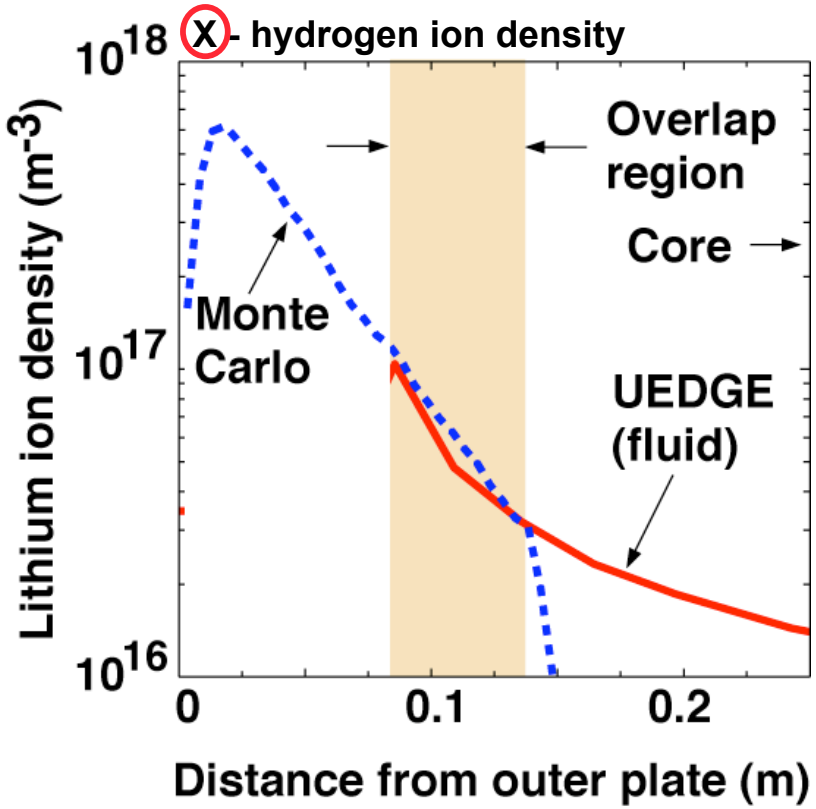
    I_b = 13 kA and I_c = 1.7kA, near detachment for b



Divertor-plate conditions changes with gas puffing should be favorable to prevent impurity intrusion



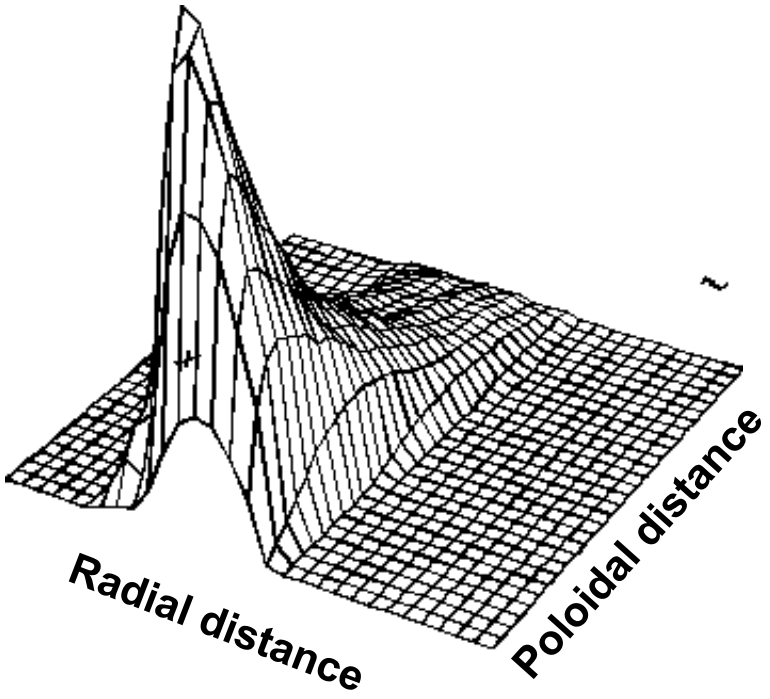
Part 2: Improving WBC/UEDGE coupling with Li for non-trace Li levels



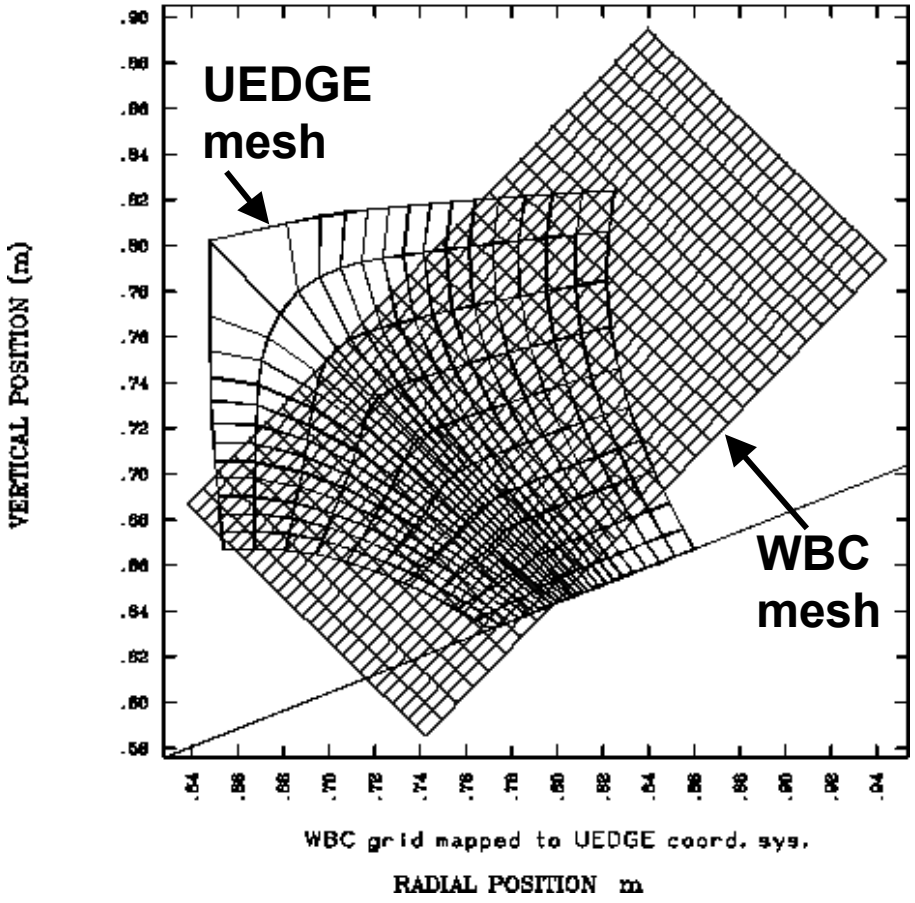
- **Approach:**
  - Interpolate in 2D between WBC and UEDGE data
  - mimic WBC Li sputtering by iteratively fitting UEDGE sputtering coefficient
  - repeated iteration with WBC

2D interpolation is provided by splines between the WBC mesh and the UEDGE mesh

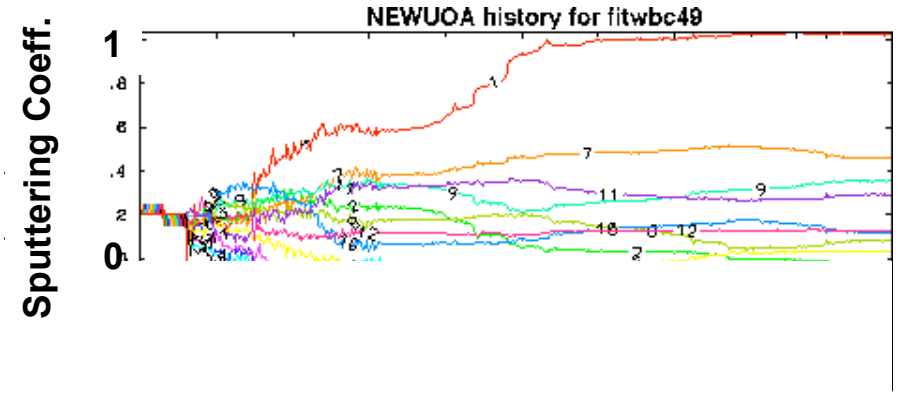
WBC lithium density

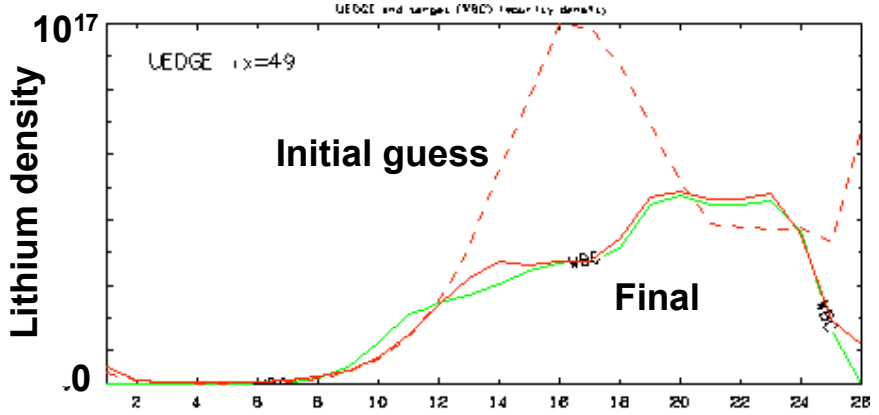


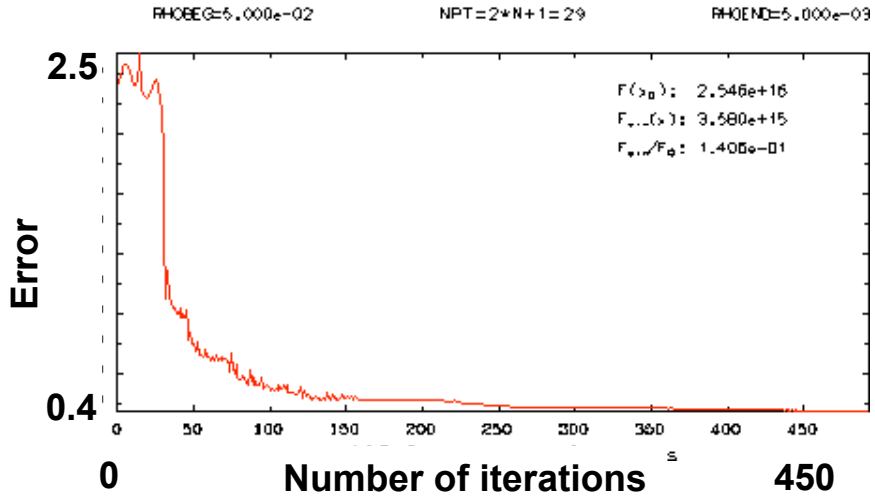
Outer divertor region

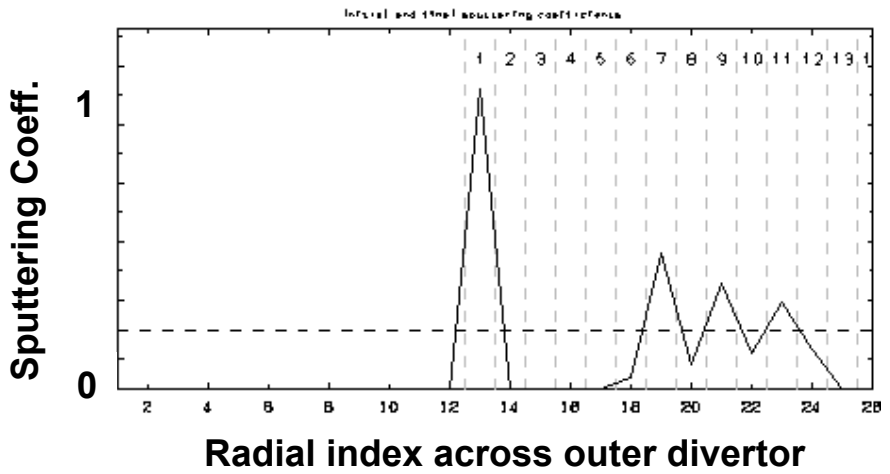


Powell's new minimization method used to iterate on sputtering coefficients across outer plate









Summary

- **Fueling of NSTX by strong gas puffing is a plausible solution, but midplane temperatures are suppressed**

- **Detailed 2D coupling between UEDGE and WBC is possible, but some issues still need to be worked out, .e.g,**
  - difference between meshes, i.e., WBC -> flux-surface mesh
  - irregular sputtering coefficient often observed in UEDGE iteration